ATTORNEY DOCKET NO. TI 35507 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicant:	K.R. Udayakumar, *et al.*
Serial No.:	10/721,932
Filed:	November 25, 2003
Title:	A METHOD FOR ETCHING A SUBSTRATE AND A DEVICE FORMED USING THE METHOD
Grp./A.U.:	1765
Examiner:	Lan Vinh Confirmation No: 8320

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ATTENTION: Board of Patent Appeals and Interferences

Sirs:

APPEAL BRIEF UNDER 37 C.F.R. §41.37

This is an appeal from a Final Rejection dated March 6, 2006, of Claims 1-21. The Appellants submit this Brief with the statutory fee of $500.00 as set forth in 37 C.F.R.§41.20(b)(2), and hereby authorize the Commissioner to charge any additional fees connected with this communication or credit any overpayment to Deposit Account No. 20-0668.

This Brief contains these items under the following headings, and in the order set forth below in accordance with 37 C.F.R. §41.37(c)(1):

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I. REAL PARTY IN INTEREST

The real party in interest in this appeal is the Assignee, Texas Instruments, Inc.

II. RELATED APPEALS AND INTERFERENCES

No other appeals or interferences will directly affect, be directly affected by, or have a bearing on the Board's decision in this appeal.

III. STATUS OF THE CLAIMS

Claims 22-25 were previously withdrawn from consideration. Accordingly, only Claims 1-21 are pending in this application. Moreover, Claims 1-5, 7-15 and 17-21 have been rejected under 35 U.S.C. § 103(a). Claims 6 and 16, however, have been objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims Each of the pending claims is being appealed.

IV. STATUS OF THE AMENDMENTS

The present Application was filed on November 25, 2003. The Appellants filed a first Request for Reconsideration on December 19, 2005 in response to a first Examiner's Action mailed August 23, 2005. The Examiner, thereafter, issued a Final Rejection on March 6, 2006. The Appellants then filed a second Request for Reconsideration on May 5, 2006. The Examiner issued an Advisory Action on May 19, 2006. The Appellants then filed a Notice of Appeal on June 6, 2006.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention is directed, in general, to a method for etching a substrate, a method for manufacturing an integrated circuit, and an integrated circuit manufactured using the method. In one embodiment, particularly that of independent Claim 1, the present invention teaches providing a substrate having an aluminum oxide etch stop layer located thereunder. (*See*, paragraphs [0026] thru [0028], and related FIGs. 2 & 3). This embodiment further teaches etching an opening in the substrate using an etchant comprising a carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a flow rate of the carbon oxide is greater than about 80 sccm and the etchant is selective to the aluminum oxide etch stop layer. (*See*, paragraphs [0029] thru [0034], and related FIG. 4).

In another embodiment, particularly that of independent Claim 11, the present invention teaches providing semiconductor devices over a semiconductor substrate, (*see*, paragraph [0025], and related FIG. 2), and providing a dielectric layer over the semiconductor devices, the dielectric layer having an aluminum oxide etch stop layer located thereunder. (*See*, paragraphs [0026] thru [0028], and related FIGs. 2 & 3). In this embodiment, openings in the dielectric layer are etched using an etchant comprising a carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a flow rate of the carbon oxide is greater than about 80 sccm and the etchant is selective to the aluminum oxide etch stop layer. (*See*, paragraphs [0029] thru [0034], and related FIG. 4). Additionally, the semiconductor devices are contacted through the openings. (*See*, paragraph [0036], and related FIG. 6).

In yet another embodiment, particularly that of independent Claim 20, the present invention teaches providing semiconductor devices over a semiconductor substrate, (*see*, paragraph [0025], and

related FIG. 2), and providing a dielectric layer over the semiconductor devices, the dielectric layer having an aluminum oxide etch stop layer located thereunder. (*See*, paragraphs [0026] thru [0028], and related FIGs. 2 & 3). In this embodiment openings are etched in the dielectric layer using an etchant comprising carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a flow rate of the carbon oxide is greater than about 80 sccm and the etchant is selective to the aluminum oxide etch stop layer. (*See*, paragraphs [0029] thru [0034], and related FIG. 4). Additionally, the semiconductor devices are contacted through the openings. (*See*, paragraph [0036], and related FIG. 6).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

(1) The first issue presented for consideration in this appeal is whether Claims 1-4 and 8-10, as rejected by the Examiner, are patentably nonobvious in accordance with 35 U.S.C. §103(a) over U.S. Patent No. 6,162,583 to Yang, *et al.* ("Yang") in view of U.S. Patent No. 6,713,310 to Song, *et al.* ("Song") and further in view of U.S. Patent No. 5,897,713 to Tomioka, *et al.* ("Tom").

(2) The second issue presented for consideration in this appeal is whether Claims 11-14 and 18-21, as rejected by the Examiner, are patentably nonobvious in accordance with 35 U.S.C. §103(a) over Yang in view of Song and further in view of Tom.

(3) The third issue presented for consideration in this appeal is whether Claim 7, as rejected by the Examiner, is patentably nonobvious in accordance with 35 U.S.C. §103(a) over U.S. Patent No. 5,324,683 to Fitch, *et al.* ("Fitch) in view of Song and further in view of Tom.

(4) The fourth issue presented for consideration in this appeal is whether Claim 17, as rejected by the Examiner, is patentably nonobvious in accordance with 35 U.S.C. §103(a) over Fitch in view of Song and further in view of Tom.

(5) The fifth issue presented for consideration in this appeal is whether Claims 5 and 15, as rejected by the Examiner, are patentably nonobvious in accordance with 35 U.S.C. §103(a) over Yang in view of Song and Tom, and further in view U.S. Patent Pub. No. 2003/0127422 to Tsuchiya ("Tsu")

VII. APPELLANTS' ARGUMENT

The inventions set forth in independent Claims 1, 11 and 20, and their respective dependent claims are not obvious over the references on which the Examiner relies.

(1) Rejection of Claims 1-4 and 8-10 under 35 U.S.C. §103

The Examiner has rejected Claims 1-4 and 8-10 under 35 U.S.C. §103(a) as being unpatentable over Yang in view of Song and further in view of Tom. The Examiner's obviousness rejection fails. Specifically, the Examiner's obviousness rejection fails because each of the references alone fails to teach or suggest the same claimed element of etching an opening in the substrate using an etchant comprising a carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a flow rate of the carbon oxide is greater than about 80 sccm and the etchant is selective to the aluminum oxide etch stop layer, as is recited in independent Claims 1, 11 and 20, and furthermore the references may not be properly combined to make this claimed element obvious.

The Examiner concedes that Yang fails to teach or suggest that its IMD2 **18** comprises an aluminum oxide etch stop layer, as well as that the etchant used to etch the IMD3 **20** located over the IMD2 **18** uses a flow rate of carbon oxide greater than about 80 sccm and is selective to the aluminum oxide etch stop layer. (See, pages 2 and 3 of the Examiner's Action dated March 6, 2006). The Examiner, however, brings in Song for the teaching or suggestion that the IMD2 **18** of Yang may comprise an aluminum oxide etch stop layer, and further brings in Tom for the teaching or suggestion that the etchant used to etch the IMD3 **20** of Yang includes a flow rate of carbon oxide greater than about 80 sccm and is selective to the aluminum oxide etch stop layer. The Examiner, however, is clearly using hindsight to combine Song and Tom with Yang to arrive at the presently claimed invention. As the Examiner must be aware, motivation based upon hindsight is improper. Thus, the combination of Yang, Song and Tom is improper.

The combination of Yang, Song and Tom is improper because there is no motivation in any of the references to combine their teachings as a whole, and not individually as the Examiner so attempts to do. The Examiner has attempted to provide motivation, albeit improper, for combining the aluminum oxide etch stop layer of Song into the structure of Yang. The Examiner has also attempted to provide motivation, albeit improper, for combining the carbon oxide flow rate of Tom into the manufacturing process of Yang. However, the Examiner has failed to actually point out any motivation, actual or implied, why it would be obvious to combine the aluminum oxide etch stop layer of Song **and** the carbon oxide flow rate of Tom together into the structure and manufacturing process of Yang. More specifically, the Examiner has failed to establish that a skilled person would, at the same time, desire to include the aluminum oxide etch stop layer of Song in to the manufacturing process of Yang **as well as** include the oxide flow rate of Tom into the manufacturing process of Yang. At the very most, the Examiner may have established that a skilled person would include the aluminum oxide etch stop layer of Song into the manufacturing process of Yang **or** include the oxide flow rate of Tom into the manufacturing process of Yang, but not both. Without motivation to combine the elements as a whole, the Examiner's motivation argument must fail.

There is clearly no motivation in the references to combine their teachings as a whole. The Appellants' application, in paragraph [0030] thereof, acknowledges the uniqueness of the aluminum oxide etch stop layer, in conjunction with the etchant that uses a flow rate of carbon oxide greater than about 80 sccm (e.g., the etch selectivity to the aluminum oxide etch stop layer). Paragraph [0030] recites in part:

> The etchant recipe used to etch the openings 410, 420, is substantially different from conventional etchant recipes. For example, the etchant recipe used to etch the openings 410, 420, comprises a carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a flow rate of the carbon oxide is greater than about 80 sccm, and exemplary greater than about 125 sccm. This specific flow rate, in combination with other tailored factors, allows the etchant to stop on the aluminum oxide etch stop layer 230 without over etching into the microelectronic device 220.

However, none of the references acknowledge the benefits of using the aluminum oxide etch stop layer as an etch stop layer, in conjunction with the acknowledgement of the benefits of using an etchant that uses a flow rate of carbon oxide greater than about 80 sccm (e.g., the etch selectivity to the aluminum oxide etch stop layer). Note that the Examiner concedes, at page 10 of the Examiner's Action dated March 6, 2006, that the references do not acknowledge such a benefit of the combination. Without this recognition, which would take substantial experimentation (or another similar recognition, which would presumably also take substantial experimentation), one skilled in the art would not make such a combination. Thus, combining the aluminum oxide etch stop layer of Song with the structure of Yang, in addition to combining the carbon oxide flow rate of Tom with the combination of Yang and Song, without more than what the Examiner has presented in the way of motivation, would be nothing more than using the presently claimed invention as a blueprint to reconstruct the elements thereof. The Examiner cannot do this. Thus, for this reason alone, the combination is improper.

Moreover, not only do the Appellants argue that the combination as a whole is improper, for the foregoing reasons, but there is also no motivation to combine the individual element of the aluminum oxide etch stop layer of Song into the structure of Yang, or alternatively to combine the individual element of the carbon oxide flow rate of Tom into the structure of Yang.

For all of the foregoing reasons, the combination of Yang, Song and Tom is improper, and thus fails to establish a prima facie case of obviousness. Claims 1-4 and 8-10 are therefore not obvious in view of the references.

(2) Rejection of Claims 11-14 and 18-21 under 35 U.S.C. §103

The Examiner has rejected Claims 11-14 and 18-21 under 35 U.S.C. §103(a) as being unpatentable over Yang in view of Song, and further in view of Tom. As previously indicated, independent Claims 1, 11 and 20 currently include the element of etching an opening in the substrate using an etchant comprising a carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a flow rate of the carbon oxide is greater than about 80 sccm and the etchant is selective to the aluminum oxide etch stop layer. As previously established, each of Yang, Song and Tom fails to teach or suggest the invention recited in independent Claims 1, 11 and 20 their dependent claims, when considered as a whole. Moreover, as also previously established, the combination of Yang with Song and/or Tom is improper for the reasons stated above. Accordingly, the cited references fail to establish a prima facie case of obviousness with respect to these claims. Claims 11-14 and 18-21 are therefore not obvious in view of the combination.

(3) Rejection of Claim 7 under 35 U.S.C. §103

The Examiner has rejected Claim 7 under 35 U.S.C. §103(a) as being unpatentable over Fitch in view of Song, and further in view of Tom. As previously indicated, independent Claims 1, 11 and 20 currently include the element of etching an opening in the substrate using an etchant comprising a carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a

flow rate of the carbon oxide is greater than about 80 sccm and the etchant is selective to the aluminum oxide etch stop layer. However, as the Examiner correctly points out, Fitch also fails to teach or suggest that its etch stop layer comprises an aluminum oxide etch stop layer, as well as that the etchant used to etch the substrate located over the etch stop layer uses a flow rate of carbon oxide greater than about 80 sccm and is selective to the aluminum oxide etch stop layer. Moreover, for the same reasons that the combination of Yang, Song and Tom is improper, the combination of Fitch, Song and Tom is improper.

Therefore, each of Fitch, Song and Tom fails to teach or suggest the invention recited in independent Claims 1, 11 and 20 and their dependent claims, when considered as a whole. Moreover, the combination of Fitch with Song and/or Tom is improper for the reasons stated above. Accordingly, the cited references fail to establish a prima facie case of obviousness with respect to this claim. Claim 7 is therefore not obvious in view of the combination.

(4) **Rejection of Claim 17 under 35 U.S.C. §103**

The Examiner has rejected Claim 17 under 35 U.S.C. §103(a) as being unpatentable over Fitch in view of Song, and further in view of Tom. As previously indicated, independent Claims 1, 11 and 20 currently include the element of etching an opening in the substrate using an etchant comprising a carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a flow rate of the carbon oxide is greater than about 80 sccm and the etchant is selective to the aluminum oxide etch stop layer. As previously established, each of Fitch, Song and Tom fails to teach or suggest the invention recited in independent Claims 1, 11 and 20 and their dependent claims, when considered as a whole. Moreover, as also previously established, the combination of

Fitch with Song and/or Tom is improper for the reasons stated above. Accordingly, the cited references fail to establish a prima facie case of obviousness with respect to this claim. Claim 17 is therefore not obvious in view of the combination.

(5) Rejection of Claims 5 and 15 under 35 U.S.C. §103

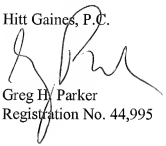
The Examiner has rejected Claims 5 and 15 under 35 U.S.C. §103(a) as being unpatentable over Yang in view of Song and Tom, and further in view Tsu. As previously indicated, independent Claims 1, 11 and 20 currently include the element of etching an opening in the substrate using an etchant comprising a carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a flow rate of the carbon oxide is greater than about 80 sccm and the etchant is selective to the aluminum oxide etch stop layer. As previously established, each of Yang, Song and Tom fails to teach or suggest the invention recited in independent Claims 1 and 11 and their dependent claims, when considered as a whole. Moreover, as also previously established, the combination of Yang with Song and/or Tom is improper.

Tsu fails to correct the deficiencies of Yang, Song and Tom. Specifically, Tsu fails to teach or suggest the element of etching an opening in the substrate using an etchant comprising a carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a flow rate of the carbon oxide is greater than about 80 sccm and the etchant is selective to the aluminum oxide etch stop layer. Accordingly, the cited references fail to establish a prima facie case of obviousness with respect to these claims. Claims 5 and 15 are therefore not obvious in view of the combination.

For the reasons set forth above, the Claims on appeal are patentably nonobvious over the cited references. Accordingly, the Appellants respectfully request that the Board of Patent Appeals and Interferences to reverse the Examiner's Final Rejection of all of the Appellants' pending claims.

Respectfully submitted,

Hitt Gaines, P.C.



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VIII. APPENDIX A - CLAIMS

1. (Original)A method for etching a substrate, comprising:

providing a substrate having an aluminum oxide etch stop layer located thereunder; and

etching an opening in said substrate using an etchant comprising a carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a flow rate of said carbon oxide is greater than about 80 sccm and said etchant is selective to said aluminum oxide etch stop layer.

2. (Original)The method as recited in Claim 1 wherein said flow rate of said carbon oxide ranges from about 150 sccm to about 220 sccm.

3. (Original)The method as recited in Claim 1 wherein said carbon oxide comprises carbon monoxide.

4. (Original)The method as recited in Claim 1 wherein said etch rate modulator comprises oxygen.

5. (Original)The method as recited in Claim 4 wherein a ratio of said fluorocarbon to said etch rate modulator is at least 2:1.

6. (Original)The method as recited in Claim 5 wherein a flow rate of said fluorocarbon ranges from about 12 sccm to about 18 sccm, and a flow rate of said etch rate modulator ranges from about 4 sccm to about 8 sccm.

7. (Original)The method as recited in Claim 1 wherein said etch rate modulator

comprises nitrogen.

8. (Original)The method as recited in Claim 1 wherein said fluorocarbon comprises C_5F_8, C_4F_8, C_4F_6, C_2F_6, CF_4, NF_3, XeF_2, F_2, CHF_3, CH_2F_2, CH_3F, SF_6, or any combination thereof.

9. (Original)The method as recited in Claim 1 wherein said substrate is a dielectric material.

10. (Original)An semiconductor device manufactured using the method for etching a substrate of Claim 1.

11. (Original)A method for manufacturing an integrated circuit, comprising:

providing semiconductor devices over a semiconductor substrate;

providing a dielectric layer over said semiconductor devices, said dielectric layer having an aluminum oxide etch stop layer located thereunder; and

etching openings in said dielectric layer using an etchant comprising a carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a flow rate of said carbon oxide is greater than about 80 sccm and said etchant is selective to said aluminum oxide etch stop layer; and

contacting said semiconductor devices through said openings.

12. (Original)The method as recited in Claim 11 wherein said flow rate of said carbon oxide ranges from about 150 sccm to about 220 sccm.

13. (Original)The method as recited in Claim 11 wherein said carbon oxide comprises carbon monoxide.

14. (Original)The method as recited in Claim 11 wherein said etch rate modulator comprises oxygen.

15. (Original)The method as recited in Claim 14 wherein a ratio of said fluorocarbon to said etch rate modulator is at least 2:1.

16. (Original)The method as recited in Claim 15 wherein a flow rate of said fluorocarbon ranges from about 12 sccm to about 18 sccm, and a flow rate of said etch rate modulator ranges from about 4 sccm to about 8 sccm.

17. (Original)The method as recited in Claim 11 wherein said etch rate modulator comprises nitrogen.

18. (Original)The method as recited in Claim 11 wherein said fluorocarbon comprises C_5F_8, C_4F_8, C_4F_6, C_2F_6, CF_4, NF_3, XeF_2, F_2, CHF_3, CH_2F_2, CH_3F, SF_6, or any combination thereof.

19. (Original)The method as recited in Claim 11 wherein at least one of said semiconductor devices is a ferroelectric capacitor.

20. (Original)An integrated circuit manufactured using the method, comprising:

providing semiconductor devices over a semiconductor substrate;

providing a dielectric layer over said semiconductor devices, said dielectric layer having an aluminum oxide etch stop layer located thereunder; and

etching openings in said dielectric layer using an etchant comprising carbon oxide, a fluorocarbon, an etch rate modulator, and an inert carrier gas, wherein a flow rate of said carbon oxide is greater than about 80 sccm and said etchant is selective to said aluminum oxide etch stop layer; and

contacting said semiconductor devices through said openings.

21. (Original)The integrated circuit as recited in Claim 20 wherein at least one of said semiconductor devices is a ferroelectric capacitor.

22. (Withdrawn)An integrated circuit, comprising:

semiconductor devices located over a semiconductor substrate;

a dielectric layer located over said semiconductor devices, said dielectric layer having an aluminum oxide etch stop layer located thereunder; and

interconnects located in said dielectric layer and in contact with said aluminum oxide etch stop layer, said interconnects contacting said semiconductor devices thereby forming an operative integrated circuit.

23. (Withdrawn)The integrated circuit as recited in Claim 22 wherein said dielectric layer and said aluminum oxide etch stop layer are located in a back-end of line of said integrated circuit.

24. (Withdrawn)The integrated circuit as recited in Claim 22 wherein said dielectric layer is a first dielectric layer and said aluminum oxide etch stop layer is a first aluminum oxide

etch stop layer, and further including multiple other dielectric layers and aluminum oxide etch stop layers located over said first dielectric layer and said first aluminum oxide etch stop layer.

25. (Withdrawn) The integrated circuit as recited in Claim 24 being void of silicon nitride etch stop layers.

IX. APPENDIX B - EVIDENCE

The evidence in this appendix includes Yang, Song, Tom, Fitch and Tsu. Yang, Song, Tom, Fitch and Tsu were entered in the record by the Examiner with the Examiner's Action dated August 23, 2005.

X. RELATED PROCEEDINGS APPENDIX

NONE